

Emerald Observatory is an iPad™ application which displays a variety of astronomical information. It is similar in that way to our flagship products, [Emerald Chronometer®](#) and [Emerald Chronometer HD](#), but designed from the start to take advantage of the iPad's larger display. Much of the supporting technology, including NTP (atomic time) and the highly accurate astronomical algorithms, was derived from Emerald Chronometer.

Clock

First of all, it's an ordinary clock. The main hands (gold colored) display the hours, minutes and seconds in the usual 12-hour format. To read it more precisely use the small numbers and tick marks on the inner edge of the rings. The thin central hand with the large white arrow head and the large white numbers and tick marks indicate the time in 24-hour format (with noon on top by default).

Emerald Observatory's time may not exactly match the time in the iPad's status bar because the iPad's clock is often not very accurate whereas Emerald Observatory's time is synchronized with the international standard atomic clocks. This is usually accurate to about +/- 0.100 seconds. This is accomplished with the [Network Time Protocol \(NTP\)](#) so it must have a Net connection to get a sync. If the Net is not available, it will fall back to the internal clock's value.

It is also possible to change the clock's time and to animate it at very high rates. See [Set Mode](#), below.

Moon

In the upper left Emerald Observatory displays the Moon as it appears from the current location at the clock's time. When the phase is a thin crescent EO simulates the illumination of the dark side by reflected light from the Earth (this is known as "Earthlight" or "[Earthshine](#)" or "the Moon's ashen glow"). In addition, the image rotates to match the Moon's apparent orientation as it moves across the sky and changes size to match the Moon's apparent size as its distance from the Earth changes around its elliptical orbit. (EO does not show the Moon's libration.)

[Animate](#) the clock at one day per tick to see the Moon go thru its phases and size changes. Tap the phase button to see the times and dates of the quarters (New, 1st Quarter, Full, 3rd Quarter).

Earth

The map of the Earth (a NASA composite of thousands of images) at the top of the screen shows which parts of the Earth are facing the Sun and which parts are in night. The image changes each month to reflect the changing snow and vegetation cover. The lights of mankind's cities are shown for the nighttime region. They roughly correspond to the human population density and level of energy use at the present time. (The data was collected by the US Air Force DMSP satellites in the mid 1990s.)

The small red dot on the Earth marks the current location being used by Emerald Observatory for its astronomical calculations (usually the current location but you can change it; see [Settings](#), below). It is important that this be the location for which you want the astronomical information to be shown and that the matching timezone is set in the iPad's Settings app.

[Animate](#) at one hour per tick to see the terminator (the "edge of night") move around the world. Animate at one month per tick to see the seasonal changes; note the changing shape and position of the terminator.

Day/date

In portrait orientation the year, month, day and day of the week appear in the upper right; in landscape they're at the bottom of the screen. They are shown in the language specified in the General->International section of the Settings app. The year is shown in red for BCE dates ("Before Common Era", a.k.a. "BC"). A small indicator appears to the right of the year in leap years.

Alarm time

If the alarm is set (see [Settings](#) below) a red circle enclosing a musical symbol appears outside the main 24-hour dial to mark the alarm time. When the white 24-hour hand reaches the alarm indicator the alarm will sound.

Main dial

- **Rise/Set rings**

There are 6 thin concentric partial rings, one for each of the classical "planets". The innermost one is for the Moon, followed by Mercury, Venus, Mars, Jupiter, and Saturn on the outside. The larger one behind the others is for the Sun. The filled region of the ring represents the time (read against the 24-hour markings) when the planet is above the horizon; it rises and sets at the ends of the arc and transits at the midpoint. Thus if the thin white arm of the 24-hour hand crosses the filled part of a planet's ring then that planet is currently above the horizon.

The large ring for the Sun is colored according to the Sun's altitude above the horizon at each time; sunrise and sunset are at the sharp boundary between red and blue.

- **Twilight hands**

There are 12 colored hands on the 24-hour dial which mark special times related to the altitude of the Sun. The light yellow one marks the time of solar noon, when the Sun is at its highest point in the sky for the day; the dark blue one is 12 hours later when the Sun is farthest below the horizon. The orange ones mark the times of sunrise and sunset. The three blue ones mark the times when the Sun is 6, 12, and 18 degrees below the horizon which define the beginning and ending of civil, nautical and astronomical [twilight](#). The dark yellow ones mark the time when the Sun is 15 degrees above the horizon, indicating the "golden hour" (which maybe be considerably longer than an hour at high latitudes) when the light is usually best for outdoor photography.

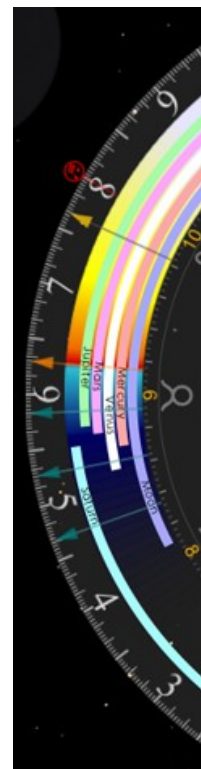
Note that at high latitudes when the sun's altitude changes slowly the golden and blue regions will elongate. In extreme cases some of the twilight hands will disappear altogether if the Sun never reaches their level. See this effect by changing to a high latitude on the [settings](#) page and then [animating](#) by days or months.

- **Timezone indicator**

Between the center and the 6 o'clock position is a simple label showing the abbreviation of the current timezone. It changes to reflect daylight time (summer time) vs standard time for those timezones that observe DST. EO's astronomical calculations depend on the timezone offset and geographic location. Use the Settings app ("General->Date & Time") to change the timezone if necessary.

- **Orrery**

Inside the main dial Emerald Observatory displays the orbital positions of the 6 innermost planets (Mercury, Venus, Earth, Mars, Jupiter, and Saturn) plus the Earth's Moon from a perspective above the Sun's north pole with respect to the present positions of constellations of the zodiac.



The approximate positions of constellations are marked by their traditional astrological symbols in large gray type.

Note that the constellation positions shown in Emerald Observatory are based on their actual positions in the present-day sky and thus do not correspond to the definitions used by western astrologers.

The best rate for [animating](#) this display depends on which planet you're concerned with. [Kepler's third law](#) shows that the inner planets orbit much faster than the outer ones. So animating by days works best for Mercury or the Moon whereas years is best for Saturn.

If you animate by years you'll notice that the Earth jitters a little. This is not a bug. It's because we're advancing by exactly one calendar year but the Earth's orbital period is about 365.25 days. So the Earth falls behind a little for three years and then catches up on the leap year. Prior to 15 October 1582 Emerald Observatory uses the [Julian calendar](#) rather than the [Gregorian](#), so you'll see the Earth jump in 1582 and then it will gradually shift in position from year to year back from that time (reflecting the error in the Julian calendar).

Symbol	Name
♈	Aries
♉	Pisces
♊	Aquarius
♋	Capricornus
♌	Sagittarius
♍	Scorpius
♎	Libra
♏	Virgo
♐	Leo
♑	Cancer
♒	Gemini
♓	Taurus

Inner subdials

- **UTC**

[UTC](#) ("Coordinated Universal Time") is a worldwide time standard based on atomic clocks that is adjusted (by the occasional addition of "[leap seconds](#)") to be very close to the mean solar time at the Royal Observatory at Greenwich, England ("GMT"). Ordinary civil time in most locations is defined by an offset from UTC.

- **Solar**

[Solar time](#) (technically: "apparent solar time") is what everyone used before the invention of clocks and timezones; it will show 12 noon at exactly the time when the Sun crosses the [meridian](#) (of course, this is also when the 24-hour hand coincides with the solar noon hand on the outer dial). Apparent solar time is what an ordinary sundial shows.

- **Sidereal**

[Sidereal time](#) tracks the apparent motion of the stars around the Earth; the Earth rotates exactly once in 24 sidereal hours as measured against the stars. That 24-hour sidereal day is a few minutes shorter than a solar (or civil) day because of the Earth's motion in its orbit around the Sun. A star that is overhead at a given sidereal time during the day will always be overhead at that same sidereal time, no matter what season it is.

The sidereal time dial is labeled with the abbreviations of the zodiac constellations and the corresponding numbers. The hour hand points to the constellation that is currently near the meridian.

UTC and sidereal time are shown in 24-hour format; solar time in 12-hour format.

Outer subdials

- **Altitude and Azimuth**

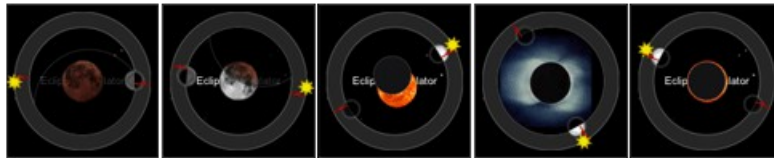
The two dials on the left side of the screen show the altitude (angle of the object up from the horizon) and azimuth (angle of the object around the horizon clockwise from North) of one of the planets at the clock's time. You can cycle through the 7 "planets" (Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn) by tapping either dial.

- **Equation of Time**

The "[Equation of Time](#)" is the difference, due primarily to the ellipticity of the Earth's orbit, between between apparent solar time (see above) and mean solar time. Mean solar time is apparent solar time averaged over a whole year. Ordinary civil time is very close to mean solar time at the standard meridian of each timezone. So EOT is the difference between your watch and a sundial on the standard meridian of your timezone.

The dial is marked in minutes; positive means the sundial is ahead. In the days of celestial navigation, the EOT for the day was an essential input to a navigator's longitude calculation.

- **Eclipse Simulator**



The small dial labeled 'Eclipse Simulator' has three icons in the outer ring, representing the Sun, Moon, and Earth's shadow and two thin red lines indicating the nodes of the Moon's orbit (points where it intersects the plane of the ecliptic). The icons are positioned around the ring according to their geocentric ecliptic longitude. When both the Sun and Moon coincide with a node then an eclipse is possible. The area inside the ring is normally empty but near the time of a lunar or solar eclipse an animation of the eclipse will appear there. Lunar eclipses are visible from an entire hemisphere of the Earth but solar eclipses are visible only from a very small area. See [here](#) for a list of times and locations of recent and upcoming eclipses (and much more).

Since eclipses happen at (or very near) full moon and new moon, you can use the "phase" button in Set mode to move forward to new and full moon dates, and see if there is anything inside the Eclipse Simulator subdial. Eclipses will only happen when the red lines indicating the nodal points are close to the Sun and Moon. You may need to move forward or backward by hours or minutes from the phase point to see the point of maximum eclipse at your location for a given eclipse. Note that solar eclipses, which are much rarer, typically are only visible on a portion of the Earth's surface. But you can simulate those eclipses with Emerald Observatory too, by entering the "location of maximum eclipse" into the latitude and longitude fields on the Settings page, and viewing the eclipse as it will appear there.

Emerald Observatory's database of locations for the Sun and Moon extend back to 4000 BCE, as mentioned above, but there is somewhat less precision for those early dates than there is for modern times. Since the difference between total and partial eclipse can be a small fraction of a degree, historical eclipses may not be shown with 100% fidelity. Modern events, however, are shown with very high precision.

Controls

Set Mode

Tapping the "Set" button just above the top of the main dial stops the clock and enters Set mode. "Set" then changes to "Reset" and two sets of buttons labeled with time units appear on either side:



The blue ones on the right move Emerald Observatory's time forward by one unit; the red ones on the left move it in reverse. The "phase" buttons change to the time of the next or previous quarter Moon (you can then read the time and date from the main display). Tapping Reset changes it back to "Set", exits Set Mode, restarts the clock, and hides the other buttons.

When the displayed time is not the current time a red label appears at the top of the screen showing the displayed time and its offset from the current time.

Emerald Observatory can be set to any date from 4000 BCE through 2800 CE.

Animation

Press and hold any of the buttons in Set Mode to animate the display (step continuously). Slide your finger off the button before raising it to "latch" the button and advance continuously. Tap it again to "unlatch" it. You can have more than one button active at once. Tap "Reset" to return to the present time.

Hot Spots

There are two additional invisible active buttons on the screen on the altitude and azimuth dials. Tapping either of them switches both dials to display the values for the next planet in the cycle (Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Sun, ...). The two cycle in opposite directions to avoid the need to cycle all the way around again if you go one too far.

NTP status indicator

The dot in the lower left blinks while NTP is communicating with the servers to synchronize the time; it is steady after that process is complete. It is green if a good sync has been accomplished, yellow otherwise.

Orientation

Emerald Observatory functions identically in both orientations but its layout is slightly different when the iPad is rotated into landscape mode:

Settings

The familiar small "i" in the lower right corner flips the display to a settings and help screen:

Alarm

The first switch enables/disables the alarm. The label immediately to the right of the switch shows the alarm time even if it is currently disabled. The "Set" and "Test" buttons appear only when it is enabled. The picker wheels appear when the "Set" button is tapped; spin them to the desired time then tap anywhere outside the pop-up to dismiss it. Tap the "Test" button to hear the sound; tap anywhere on the screen to silence it.

The alarm will sound for about 20 seconds (10 rings) or you can tap anywhere on the screen to silence it. It is based on real time only; it does not sound if the alarm time is reached in Set mode. It will sound if the screen is locked while Emerald Observatory is running. If run under iOS 3.2 the alarm will not sound unless Emerald Observatory is the currently active app; with iOS 4.2 or later a local notification will be issued in that case.

The alarm will repeat at the same time each day.

Noon on Top

Most 24-hour clocks have midnight (0 or 24) at the top of the dial. But when the clock also shows an indication of the day/night hours it is convenient to have noon (12) on top. As there seems to be little consensus on this issue, EO lets you choose for yourself.

Use Location Services

This switch controls whether Emerald Observatory will use the iPad's builtin location finding hardware. For those situations where that is not sufficient (e.g. a WiFi-only iPad not near a registered WiFi node) you can turn the switch to OFF and enter your own values for latitude and longitude. Enter the values in decimal format with negative numbers for west longitudes and south latitudes. Check the red dot on the Earth map on the main screen to ensure the values are correct. Also make sure that the corresponding timezone is set. (The timezone abbreviation is displayed at the very top of the Settings/Help screen and on the main dial; it is set with the Settings app, "General->Date & Time".)

Disable Auto-lock

The final pair of switches disable the iPad's automatic sleep mode. The top one controls what happens when your iPad is connected to a power source, the bottom one when it's running on battery. If the switch is ON your iPad will not sleep regardless of the Auto-lock setting in the Settings app. Be careful with the 'on battery' setting; Emerald Observatory will deplete the iPad's battery in just a few hours.

Help

The remainder of the screen is a brief summary of the app's capabilities. Scroll to the bottom to see the boring copyright notices.

Customer Support and FAQ: <http://emeraldsequoia.com/eo/eosupport.html>

Release Notes: <http://emeraldsequoia.com/eo/ReleaseNotes.html>

Copyright information: <http://emeraldsequoia.com/eo/Credits.html>